head of the pancreas are really small localized growths of the common bile duct, ampulla, or papilla of Vater. The greatest number of patients suffering from this disease enter the hospital two to three months after the onset of jaundice. The intervening time has usually been spent by the physician in waiting to observe whether a suspected stone will pass or not. This is the period most valuable for the patient. The proper procedure to follow in a person over middle age who becomes deeply jaundiced, whether painlessly or not, is to attempt immediately to discover, by means of the duodenal tube, whether the main ducts in the region suspected are absolutely blocked or not. If they are, one or both of them, the diagnosis of new growth should be made; the case should at once become a surgical one, and no further time be spent in "watchful waiting." A cholecystenterostomy at this time will be of greater assistance to the patient and prevent the dire consequences of a fully established malignant icterus. The mortality of this preliminary operation would probably be very much lower at this time than when performed months later.

Four to six weeks may safely be allowed to elapse. The nature of the growth permits of this delay, for it grows but slowly and has little tendency to metastases. With more assurance and a much better hope of success the second stage of the operation may be undertaken. The successful issue of the radical excision of new growths involving these large ducts will rest in great part on the alacrity with which the physician makes this early diagnosis and calls to his aid a competent surgeon.

General Summary. In most of the new growths involving the bile and pancreatic ducts we are dealing with localized and relatively benign "rodent ulcers." The duodenal tube, in the great majority of cases, allows of early and absolute diagnosis. Delay, with its concomitant cholemia, hemorrhage, and rapid emaciation can thus be avoided and the powers of modern surgery be hopefully invoked to continue, with ever bettering results, a warfare on this type of malignant growth.

# THE ABSORPTION OF PROTEIN AND FAT AFTER THE RESECTION OF ONE-HALF OF THE SMALL INTESTINE.

By Walter W. Palmer, M.D.,

HOUSE PHYSICIAN, EAST MEDICAL SERVICE, MASSACHUSETTS GENERAL HOSPITAL.

(From the Medical Service and the Chemical Laboratory of the Massachusetts General Hospital.)

Studies of absorption in cases with extensive resection of the small intestine have been made by several investigators. In August, 1913, Dr. E. A. Codman removed from a woman, aged forty years, 235 cm. intestine with tuberculous ulcers and strictures. Since the operation I have made certain observations which are of sufficient interest to report.

A housewife, now forty years old, with a family of five healthy children, presented the following history: In 1895 she was in the hospital with symptoms of hyperthyroidism, which quickly subsided. She had an acute appendix removed in 1910.

The patient entered the hospital June 20, 1913, on the east surgical service, complaining of cramp-like pains in the lower abdomen and a loss of eight and a half pounds in weight during the previous six weeks. There was some right-sided tenderness, which was considered voluntary. From the rœntgen-ray plates Dr. Holmes made the diagnosis of probable extensive adhesions in the lower abdomen. Dr. Codman operated for chronic obstruction of the small intestine. At operation he found many tuberculous ulcers and strictures in the lower third of the small intestine and in the ascending colon. A jejuno-colostomy was made. A good recovery from the operation followed, and while in the wards there was no gastro-intestinal disturbance. About a week after leaving the hospital's convalescent home, August 1, 1913, a distressing diarrhea, associated with lower abdominal cramps, began. There was no vomiting, and no blood had been noticed in the feces. Loss of weight and strength had been marked.

On August 30, 1913, the patient entered the east surgical service. About the umbilicus there was marked visible peristalsis. No masses could be felt. Dr. Codman performed a second operation, in which he resected the lower half of the small intestine and the ascending colon, making in all 235 cm. of resected intestine. It was thought that all the diseased intestine was removed. Also, it was estimated that at least half of the small intestine had been removed. The small intestine was joined to the colon by a lateral anastomosis. A good recovery from the immediate effects of the operation was made.

On September 25, 1913, the patient was transferred to the east medical service for regulation of diet. On a liquid and soft-solid diet there were daily two or three large, liquid, foul-smelling stools, showing an excess of fatty acids and soaps; little neutral fat and no mucus, pus, or blood was seen At the suggestion of Dr. Edsall I carried out an absorption experiment at this time. (See Table I.)

At the time of leaving the hospital, October 15, 1913, after several days of low fat diet, she was gaining weight and passing daily one or two stools, which were fairly well formed. She was much better generally. Soon after leaving the hospital, however, she developed numbness and peculiar "drawing sensations" in the legs, forearms, and face. The family physician recognized the condition as tetany, and sent the patient to the hospital October 27, 1913. Chvostek's, Trousseau's, and Erb's phenomena were all well marked. A second absorption experiment and in addition a study of the calcium metabolism were carried out. (See Table II.) Following the experiment she was given a diet low in fat and in addition 15 grains of calcium lactate four times a day. Toward the end of the metabolism experiment the tetany condition improved slightly. After the institution of the low fat diet and the use of calcium there was marked and rapid improvement, until on November 24, neither the Chvostek nor Trousseau phenomena could be elicited and the electrical reactions were normal. There was no numbness of the hands or face. She was passing one or two large semiformed stools a day. She left the hospital November 26.

During December following she had a good appetite and gained in weight and strength. In January and February, however, her appetite failed markedly, her stomach was "sour," and she began to lose weight. There had been no attacks of tetany. Suddenly, on February 24, she was seized with a severe attack of tetany, involving her legs, arms, and face. Three days later she entered the hospital, where again calcium was given, and in three days more the symptoms of tetany had disappeared. She went home after a two weeks' stay in the hospital. At this time the stools showed little change in the gross appearance, but microscopically there was more neutral fat than at her previous entries.

During March, April, and May, while at her home, she made little gain. Her appetite was capricious, she vomited frequently, and tetany symptoms were present in varying degrees most of the time. On May 20 the patient entered the hospital for the seventh time. Her general appearance was not as good as six months previously, but the weight, eighty pounds, was about the same. Trousseau's sign was easily elicited. There was no Chvostek's phenomenon. The electrical reactions were not secured. In the upper abdomen, directly above the umbilicus, lying transversely, was a sausage-shaped tumor about 7 cm. in length. A similar tumor could be made out under the scars of the previous operations. A third absorption experiment was carried out. Shortly after the end of the observations, without apparent cause, she became mildly delerious, with ideas of persecution, insisting on going home, which she was allowed to do.

The urine showed no albumin, sugar, acetone, or diacetic acid during the entire time she was under observation in the hospital. The Wassermann reaction on the blood was negative. Examination of the blood revealed nothing remarkable.

METHODS AND DIET. *Urine.* Total nitrogen, urea, and ammonia were determined according to Folin's new methods.[1] For uric acid and creatinin the methods of Folin were used.[2] Creatin was determined by Folin's method.[3] The colorimetric method described by Myers and Fine[4] was used to estimate indican. For the hydrogen ion concentration the method of Henderson and Palmer,[5] titratable acid, Henderson's method,[6] and calcium, McCrudden's method,[7] were employed.

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[1] Jour. Biol. Chem., 1912, xi, 493, 507, 523.

*Feces.* In periods 1 and 2 large amounts of 95 per cent. alcohol were added to the fresh feces, which were dried on the water-bath to a constant weight. After pulverization nitrogen was determined by the usual Kjeldahl method; fat and fatty acid according to the method of Folin and Wentworth.[8] In period 3 the nitrogen determinations were made on the fresh stools, which were kept frozen until the end of the experiment. The fat estimations were made after drying, as described above. To estimate the calcium in the feces the organic matter was destroyed by nitric and sulphuric acid after the method of Neumann[9] and the determinations made as in the method of urine.

*Diet.* In periods 1 and 3 the diet consisted of eggs, bread, sugar, butter, and milk accurately weighed and the nitrogen and fat computed from the tables of Atwater and Bryant,[10] with the exception that the fat and nitrogen in the milk were determined by analysis.

In period 2 the food was analyzed for nitrogen, fat, and calcium. The food mixture used was the one employed by Folin[11] in his work on normal urines:

| | |
|---|---|
| Whole milk | 500 c.c. |
| Cream (18 to 22 per cent. fat) | 300 c.c. |
| Eggs (white and yolk) | 450 gms. |
| Horlick's malted milk | 200 gms. |
| Sugar | 20 gms. |
| Sodium chloride | 6 gms. |

Water enough to make the whole up to two liters. In addition, soda crackers were allowed.

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[2] Approximately Complete Analyses of Thirty "Normal" Urines, Amer. Jour. Physiol., 1905, xiii, 45.

[3] Beiträg zur Chemie des Kreatinins und Kreatins im Harn, Zeit. f. Physiol Chem., 1904, xli, 223.

[4] Essentials of Pathological Chemistry, New York, 1913, p. 93.

[5] The Intensity of Urinary Acidity in Normal and Pathological Conditions, Jour. Biol. Chem., 1913, xiii, 393.

[6] A Critical Study of the Process of Acid Excretion, Jour. Biol. Chem., 1911, ix, 403.

[7] The Determination of Calcium in the Presence of Magnesium and Phosphates; The Determination of Calcium in Urine, Jour. Biol. Chem., 1911, x, 197.

[8] A New Method for the Determination of Fat and Fatty Acids in Feces, Jour. Biol. Chem., 1910, vii, 421.

[9] Einfache Veraschungsmethode, Zeit. f. Physiol. Chem., 1903, xxvii, 117.

[10] The Chemical Composition of American Food Materials, Bull. No. 28 (revised edition) United States Department of Agriculture, Office of Experiment Stations.

[11] Loc. cit.

TABLE I—Period 1.

| Date. October | Volume of urine c.c. | Hydrogen ion concentration.[1] | Acid n/10 c.c. | Ammonia n/10 c.c. | Acid + ammonia. | Acid ÷ ammonia. | Total nitrogen. | Urea –N. | Ammonia –N. | Creatinin –N. | Uric acid –N. | Nitrogen in feces. | Nitrogen in urine and feces. | In per cent. of total nitrogen. Urea. | Ammonia. | Creatinin. | Uric acid. | Food. Nitrogen. | Fat. | Fat in feces. | Fatty acid in feces.[2] | Weight in kilos. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 985 | 5.8 | 107 | 657 | 764 | 0.17 | 4.12 | 3.02 | 0.92 | 0.12 | 0.04 | | | 74 | 22 | 2.8 | 0.9 | ..... | ...... | .... | .... | 36.3 |
| 6 | 560 | 6.0 | 80 | 495 | 575 | 0.16 | 4.24 | 2.97 | 0.69 | 0.10 | 0.06 | | | 70 | 16 | 2.5 | 1.4 | ..... | ...... | .... | .... | 36.3 |
| 7 | 790 | 5.8 | 122 | 667 | 789 | 0.18 | 4.54 | 2.66 | 0.94 | 0.12 | 0.06 | 7.18 | 30.34 | 59 | 21 | 2.6 | 1.2 | 35.06 | 297.54 | 81.2 | 60.5 | 36.4 |
| 8 | 985 | 5.8 | 100 | 650 | 750 | 0.15 | 4.95 | 2.53 | 0.91 | 0.13 | 0.04 | | | 51 | 18 | 2.7 | 0.8 | ..... | ...... | .... | .... | 36.4 |
| 9 | 620 | 5.8 | 93 | 496 | 589 | 0.19 | 5.31 | 3.73 | 0.70 | 0.12 | 0.04 | | | 70 | 13 | 2.2 | 0.7 | ..... | ...... | .... | .... | 36.5 |

[1] Expressed as the logarithm of the actual value, the minus sign being omitted.

[2] Includes the soap. This holds in the remaining table.

TABLE II—Period 2.

| Date. November | Volume of urine c.c. | Hydrogen ion concentration. | Acid n/10 c.c. | Ammonia n/10 c.c. | Acid + Ammonia. | Acid ÷ Ammonia. | Total nitrogen. | Urea – N | Ammonia – N. | Creatinin – N | Uric acid – N. | Nitrogen in feces.[1] | Nitrogen in urine and feces. | Food nitrogen. | In per cent. of total nitrogen. Urea. | Ammonia. | Creatinin. | Uric acid. | Food. Nitrogen. | Fat. | Fat in feces. | Fatty acid in feces. | Calcium in food. | Calcium in urine. | Calcium in feces. | Weight in kilos. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 580 | 5.7 | 130 | 753 | 883 | 0.17 | 4.30 | 2.05 | 1.06 | 0.18 | 0.07 | .... | ..... | .... | 48 | 39 | 4.1 | 1.7 | ..... | ..... | ... | .... | ..... | ..... | ..... | 37.7 |
| 3 | 438 | 5.7 | 155 | 770 | 925 | 0.20 | 4.38 | 2.29 | 1.08 | 0.19 | 0.07 | .... | ..... | .... | 52 | 25 | 4.3 | 1.6 | ..... | ..... | ... | .... | ..... | ..... | ..... | 37.8 |
| 4 | 405 | 6.0 | 143 | 735 | 878 | 0.19 | 5.06 | 2.83 | 1.03 | 0.18 | 0.07 | 14.17 | 37.45 | 52.97 | 56 | 20 | 3.6 | 1.4 | 52.97 | 457.4 | 129 | 80.5 | 7.117 | 0.029 | 5.323 | 37.9 |
| 5 | 428 | 6.0 | 137 | 687 | 824 | 0.20 | 4.65 | 2.93 | 0.96 | 0.19 | 0.13 | .... | ..... | .... | 63 | 21 | 4.0 | 2.8 | ..... | ..... | ... | .... | ..... | ..... | ..... | 37.8 |
| 6 | 660 | 6.0 | 135 | 635 | 770 | 0.21 | 4.89 | 3.12 | 0.88 | 0.20 | 0.12 | .... | ..... | .... | 64 | 18 | 4.0 | 2.4 | ..... | ..... | ... | .... | ..... | ..... | ..... | 38.0 |

[1] Owing to the large amounts of free ammonia in the stools (as much as 0.43 gm. ammonia-nitrogen in a single stool) there was undoubtedly considerable stool nitrogen lost in the method of preparation for analysis.

## TABLE III.

| Date. November | Volume of urine c.c. | Specific gravity. | Hydrogen ion concentration. | Acid n/10 c.c. | Ammonia n/10 c.c. | Acid + ammonia n/10 c.c. | Acid ÷ ammonia. | Ammonia – N |
|---|---|---|---|---|---|---|---|---|
| 9 | 540 | 1016 | 5.8 | 75 | 488 | 563 | 0.15 | 0.68 |
| 10 | 845 | 1010 | 5.8 | 127 | 508 | 635 | 0.25 | 0.71 |
| 11 | 805 | 1013 | 5.9 | 148 | 494 | 642 | 0.30 | 0.69 |
| 12 | 350 | 1022 | 5.6 | 104 | 376 | 480 | 0.28 | 0.53 |
| 13 | 545 | 1012 | 5.7 | 104 | 328 | 432 | 0.32 | 0.46 |
| 14 | 935 | 1007 | 5.3 | 59 | 304 | 363 | 0.20 | 0.43 |
| 15 | 450 | 1017 | 5.5 | 113 | 346 | 439 | 0.33 | 0.49 |
| 16 | 1050 | 1007 | 5.7 | 65 | 346 | 411 | 0.19 | 0.49 |
| 17 | 855 | 1010 | 5.9 | 68 | 264 | 332 | 0.26 | 0.37 |
| 18 | 875 | 1010 | 5.8 | 114 | 265 | 379 | 0.43 | 0.37 |

## TABLE IV—Period 3.

| Date. May | Volume of urine c.c. | Hydrogen ion concentration. | Acid n/10 c.c. | Ammonia n/10c.c. | Acid + ammonia. | Acid ÷ ammonia. | Total nitrogen. | Urea – N. | Ammonia – N. | Creatinin – N. | Creatin – N. | Creatin = Creatinin – N. | Uric Acid – N. | Indican. | In per cent of total nitrogen. | | | | | | Food. | | Nitrogen in feces. | Fat in feces. | Nitrogen in urine and feces. | Weight in kilos. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Urea. | Ammonia. | Creatinin. | Creatin. | Creatin – creatinin | Uric acid. | Nitrogen. | Fat. | | | | |
| 25 | 420 | 6.1 | 156 | 650 | 806 | 0.24 | 5.37 | 3.26 | 0.91 | 0.23 | 0.053 | 0.29 | 0.07 | 0.80 | 63 | 17 | 4.3 | 1.0 | 5.4 | 1.2 | ..... | ..... | ..... | ... | ..... | 36.6 |
| 26 | 460 | 6.0 | 200 | 785 | 985 | 0.26 | 5.00 | 2.56 | 1.10 | 0.23 | 0.100 | 0.33 | 0.06 | 0.75 | 51 | 22 | 4.6 | 2.0 | 6.6 | 1.1 | ..... | ..... | ..... | ... | ..... | 36.3 |
| 27 | 300 | 6.0 | 215 | 915 | 1130 | 0.24 | 6.05 | 3.53 | 1.28 | 0.23 | 0.096 | 0.33 | 0.06 | 0.50 | 58 | 21 | 3.8 | 1.6 | 5.4 | 1.0 | 50.80 | 443.7 | 12.67 | 136 | 40.58 | 35.7 |
| 28 | 265 | 5.7 | 190 | 650 | 840 | 0.29 | 4.59 | 2.55 | 0.91 | 0.20 | 0.048 | 0.25 | 0.02 | 0.69 | 56 | 20 | 4.4 | 1.0 | 5.5 | 0.3 | ..... | ..... | ..... | ... | ..... | 35.6 |
| 29 | 485 | 6.0 | 214 | 880 | 1094 | 0.24 | 6.90 | 4.58 | 1.23 | 0.22 | 0.048 | 0.27 | 0.05 | 0.72 | 67 | 18 | 3.2 | 0.7 | 3.9 | 0.7 | ..... | ..... | ..... | ... | ..... | 35.5 |

## TABLE V—Summary of Results.

| Period. | Food nitrogen. | Urine nitrogen. | Feces nitrogen. | Per cent. nitrogen ingested lost in feces. | Nitrogen balance. | Food fat. | Total feces fat. | Fatty acid in feces.[1] | Per cent. fat injested lost in feces. | Per cent. fatty acid of fat in feces.[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35.06 | 23.16 | 7.18 | 20.4 | +4.71 | 297.54 | 82.2 | 60.5 | 27.3 | 73.6 |
| 2 | 52.97 | 23.28 | 14.17 | 21.1 | +15.52 | 129.4 | 129.0 | 80.5 | 28.2 | 62.4 |
| 3 | 50.80 | 27.91 | 12.67 | 25.0 | +10.22 | 443.7 | 136.0 | 51.7 | 30.7 | 38.0 |

[1] Includes the soaps.

Discussion. Extensive resections of the small intestine with recovery have been reported from time to time. In 1912 Flint[12] gathered together the cases, 59 in all, in which 200 cm. or over had been resected, giving reference and result in each case. Repetition of these cases is unnecessary. The most remarkably extensive resection yet reported is by Denk,[13] in a woman, aged sixty-one years, from which 540 cm. (21 feet 3 inches) of the small intestine were removed. A good recovery without intestinal disturbance is claimed for this patient. This extraordinary case stands alone in the literature, and one should be cautious in accepting it as a criterion for maximum resection.

The effect on absorption and metabolusm of extensive resection of the small intestine has been studied experimentally in animals by Senn,[14] Monari,[15] Trzebicky,[16] Erlanger and Hewlett,[17] and Flint.[18] There is a general agreement among these investigators that half of the small intestine in dogs may be removed without seriously affecting growth of metabolism. As much as 75 per cent. of the intestine has been removed, with recovery, but the dogs usually die from inanition, due to uncontrollable diarrhea. Monari, however, makes the statement that seven-eighths of the small intestine may be resected without serious impairment.

Metabolism studies following extensive resection of the intestine in men have been made in a few cases, which were reviewed in 1910 by Mijaki[19] and again in 1912 by Flint.[20] The grade of metabolic disturbance, both in men and in animals, appears not to be wholly dependent on the length of intestine resected, but in part on certain indeterminable factors. The results of animal experimentation are suggestive and important, but care is necessary in the interpretation of their significance in human physiology. It must be remembered that not all cases of intestinal resection in men are comparable to animal resections. Very frequently there are diseased conditions of the intestine in men not reproduced or that are not reproducible in animals. In men the condition of the intestine is of the utmost importance and should be carefully considered whenever extensive resections are contemplated. The greater the certainty of leaving nothing but healthy intestine the more frequently may extensive resection be successfully undertaken. It would seem doubtful, if even under the most favorable circumstances, more than half of the small intestine should be removed in human individuals. I am well aware that in certain acute conditions, such as volvulus, intussusception, and incarcerated herniæ, where there is beginning gangrene the surgeon is left no choice and must take the chance.

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[12] The Effect of Extensive Resection of the Small Intestine, John Hopkins Bull., 1912, xxiii, 127.

[13] Ausgedehnte Darmresektion mit Ausgang in Heilung, Wiener klin. Woch., 1907, xx, 1649.

[14] Experimental Contributions to Abdominal Surgery, Chicago, 1892.

[15] Expermentelle Untersuchungen über die Abtragung des Magens und Dünndarms beim Hunde, Beiträge z. klin. Chir., 1896, xvi, 479.

[16] Ueber die Grenzen der Zulässigkeit der Dünndarmresektion, Arch. f. klin. Chir., 1894, xlviii, 54.

[17] A Study of the Metabolism in Dogs with Shortened Small Intestines, Amer. Jour. Physiol., 1901, vi, 1.

[18] Loc. cit.

[19] Ueber ausgedehnte Darmresektion, Arch. f. klin. Chir., 1910, xciii, 768.

[20] Loc. cit.

In men and animals alike fat absorption is most disturbed, nitrogen less interfered with, and carbohydrates are nearly always absorbed in a normal manner. The highest percentage, 34.2, of nitrogen loss in the feces is found in Axhausen's case,[21] in which 475 cm. of small intestine were resected. The nitrogen found normally in the feces, according to Schmidt and Strasburger,[22] is 4 to 6 per cent. Zusch[23] reports the highest percentage, 38, of fat lost in the feces. Schmidt and Strasburger give the average daily loss of fat in the stools of a normal individual taking a mixed diet as 4 to 6 per cent. of the intake. According to these observers, and also Folin and Wentworth,[24] 60 to 70 per cent. of the fat recovered in the stools is in the form of fatty acid. The loss of both fat and nitrogen in our case is marked. The nitrogen loss, 20.4 per cent., in period 1, 21.1 per cent. in period 2, 25 per cent. in period 3, is four to five times the normal loss. Even a greater loss in fat occurs, 27.3 per cent. in period 1, 28.2 per cent. in period 2, 30.7 per cent. in period 3, which is five or six times the loss in normal individuals. There occurs a marked reduction in the percentage of fatty acids in the stools, 73.6 per cent. in period 1, 62.4 per cent. in period 2, and 38 per cent. in period 3. The progressively poorer absorption of fat and nitrogen, together with the reduction in the degree of saponification in the stool, is probably due to the progress of the tuberculous condition in the intestines.

In the distribution of the urinary nitrogen among urea, ammonia, uric acid, and creatinin the high percentage of ammonia with a relatively low urea is at once noticeable. Folin[25] in his analyses of thirty normal urines found 3.3 to 5.1 per cent. ammonia-nitrogen with the urinary total nitrogen ranging between 14.8 to 18.2 gms., 4.2 to 11.7 per cent. where the urinary nitrogen varied between 4.8 to 8 gms. In my case in period 1, the urinary nitrogen varying between 4.1 and 5.2 gms., the ammonia-nitrogen was between 13 and 22 per cent. In period 2 a greater range of 18 to 39 per cent. ammonia-nitrogen, with 4.3 to 5 gms. of urinary nitrogen, occurs. The urinary nitrogen is slightly higher in period 3, 4.5 to 6.9 gms., and the ammonia-nitrogen varies between 18 and 22 per cent. Uric acid and creatinin in periods 1 and 2 do not vary markedly from the normal, both being quite constant from day to day. There is, however, a gradual increase in the absolute amount of creatinin during the three periods, as may be seen on examination of the tables. In period 1 the daily average creatinin-nitrogen excretion is 0.118 gm., period 2, 0.188 gm., and in period 3, 0.222 gm. During the investigation there was no marked change in weight. There is not sufficient data available to determine the significance of this. The increased metabolism known to occur in tuberculosis is undoubtedly an important factor. In period 3 creatin appears in the urine for the first time. The creatinin, however, is very constant. The appearance of creatin is probably explained by the fact that the patient had a temperature varying between 99° and 100° during the experiment. The progress of the tuberculous condition in the intestine may also have been a factor. On the fourth day of the experiment, May 29, both creatinin and uric acid are low. Careful inquiry failed to reveal any loss of urine, but this possibility is not absolutely ruled out.

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[21] Axhausen, G. Ueber die obere Grenze f. die Zulässigkeit ausgedehnter Dünndarmsektion, Mitteil. a.d. Grenzgeb. der Med. u. Chir., 1909–10, xxi, 55.

[22] Die Fäzes des Menschen, Berlin, 1901.

[23] Stoffwechsel nach ausgedehnter Dünndarmresektion, Berl. med. Woch., 1901, xxxv, 739.

[24] Loc. cit.

[25] Loc. cit.

Especially interesting is the indican excretion. The excretion of indican in normal individuals in twenty-four hours is usually given as 10 to 50 milligrams.[26] Hawk and his collaborators[27] have found as much as 114 mg. in twenty-four hours. On the first day of period 3 my patient excreted 800 mg. of indican, an amount in excess of any thus far reported.[28] Indican has been considered for a long time an index of the degree of intestinal putrefaction.

A study of the acid factors of the urine has brought to light little that is not revealed in the nitrogen constituents. The hydrogen ion concentration varies very little, and is within the normal limits as reported by Henderson and Palmer.[29] The ammonia is high when compared to the acid. This, of course, makes the acid-ammonia ratio varying between 0.15 and 0.29 much lower than the normal of 0.75 reported by Henderson and Palmer.[30] The low ratio is evidently due to the increase in ammonia rather than any decrease in acid excretion. Following period 2 the acid factors were studied for several days. (See Table III.) A steady and marked reduction in the ammonia occurs. During this time the tetany was improving rapidly. Increase in the ammonia excretion has been found to occur in tetany by MacCallum and Voegtlin[31] and others. Some form of acidosis was suggested by the high ammonia. Accordingly following period 3, sodium bicarbonate as a test for acidosis, suggested by Palmer and Henderson[32] were employed. There was no reduction in urinary acidity after 5 grams of sodium bicarbonate by mouth, nor was there any change in the titratable acid or ammonia. After the ingestion of 10 grams of sodium bicarbonate, while the hydrogen ion concentration showed no change, there was some reduction in both titratable acid and ammonia. It was not possible to study the effect of larger doses because of the unwillingness on the part of the patient to continue the experiment. Acetone bodies were persistently absent from the urine in all the periods. It seems justifiable to conclude that there was no marked acid intoxication to explain the high urinary ammonia.

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[26] Neubauer-Huppert's Lehrbuch. Analyse des Harns, Elfte Auflage, Wiesbaden, 1913, xi, 797.

[27] Intestinal Putrefaction during Copious and Moderate Water-drinking with Meals, Arch. Int. Med., 1911, vii, 610, Sherwin, C. P., and Hawk, P. B.: The Putrefactive Processes in the Intestine of a Man during Fasting and during Subsequent Periods of Low and High Protein Ingestion, Jour. Biol. Chem., 1912, xi, 169.

[28] Dr. Denis informs me that she has found as much as 500 mg. of indican in a twenty-four-hour specimen of urine.

[29] Loc. cit.

[30] The Several Factors of Acid Excretion, Jour. Biol. Chem. 1914, xvii, 305.

[31] The Relation of Tetany to the Parathyroid Glands and to Calcium Metabolism, Jour. Exp. Med., 1909, xi, 118.

In connection with the increased urinary ammonia the ammonia in the stools is interesting. During period 2 as much as 0.43 gm. in a single stool was found That the extensive putrefaction in the intestine may be largely responsible for the high ammonia in the urine seems not improbable. Folin and Denis[33] found in their cat experiments that the large part of the ammonia which was converted into urea in the liver came from the large intestine, and apparently was the result of putrefaction. It is quite possible that more ammonia escapes conversion into urea than normally, due to the large amount or to incompetency on the part of the liver.

The observations on the calcium metabolism in the second period were made because of the tetany. Normally, calcium is excreted largely by the bowel. During tetany following parathyroidectomy there is a marked loss of calcium from the body. The importance of calcium in these experimental conditions is further illustrated by the remarkable improvement following its administration.[34] The various studies of calcium metabolism, however, with all the difficulties encountered, leave one in doubt as to its exact significance in the several conditions in which tetany is met. It is interesting in my case that during the five days, a total of only 29 mgs. was excreted in the urine. This low amount of calcium in the urine may be explained in part by the rapidity with which the food passed through the intestinal tract, or the diseased condition of the intestine may be a factor. The absorption of small amounts of calcium and possibly the presence of an insufficient amount in the body, as a factor in the causation of the tetany, is suggested by these observations, but by no means proved. It should be remembered that there occurred definite improvement in the tetany in period 2 before calcium was given.

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[32] Clinical Studies in Acid Base Equilibrium and the Nature of Acidosis, Arch. Int. Med., 1913, xii, 153.

[33] The Origin and Significance of the Ammonia in the Portal Blood, Jour. Biol. Chem., 1912, xi, 161.

[34] MacCallum, W. G., and Vœgtlin, Carl, loc. cit.

SUMMARY. 1. Absorption studies after resection of the lower half of the small intestine are reported.

2. The loss of nitrogen in the stools is four to five times that of normal individuals.

3. The loss in fat in the stools is five to six times the normal loss.

4. A high urinary indican, 800 mgs. is reported.

5. Ammonia forms a much larger part of the urinary nitrogen than in normal individuals. This is probably due to the extensive putrefaction taking place in the intestine.

6. The success with which a large portion of the intestine may be removed depends to a large degree on the condition of the intestine remaining. This fact I believe to be important and should be considered carefully before extensive resections are undertaken.

7. A diet low in fat and moderately low in protein should be given in cases where much intestine has been removed.

I wish to thank Dr. Edsall for his kindly interest and many valuable suggestions during the investigation.

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# THE RŒNTGENOLOGIC METHOD OF DIFFERENTIATING BETWEEN ULCER AND CANCER OF THE STOMACH AND DUODENUM.

By Arthur F. Holding, M.D.,

ATTENDING RŒNTGENOLOGIST, GENERAL MEMORIAL HOSPITAL; CHIEF OF RŒNTGEN CLINIC, CORNELL UNIVERSITY MEDICAL COLLEGE, NEW YORK.

DURING the past two years I have heard several eminent gastroenterologists and internists, as well as numerous general practitioners, make statements in the public discussion of scientific papers concerning the rœntgenologic diagnosis of ulcers of the stomach and duodenum which showed that there is a widespread belief that these lesions are evidenced by a single irregular bismuth shadow. The commonest errors noted were diagnoses based on a "persistent bismuth fleck," a "spasmodic or organic hour-glass of the stomach," or a "gastric bismuth residue after six hours."

PRELIMINARY REMARKS. We recognize that anatomically and physiologically the first portion of the duodenum is not considered a part of the stomach, but symptomatically and surgically it is perhaps the most important part. It is rarely visible fluoroscopically, and in order to obtain its rœntgenographic picture, buttermilk instead of gruels must be used for suspending the opaque meal. Since the first portion of the duodenum is embryologically, symptomatically, surgically, and rœntgenographically a part of the